MAY 5 1952

VOL. XIII, No. 2 FEBRUARY, 1952

610.5
B73

# BORDEN'S REVIEW

# *of*

# NUTRITION RESEARCH

## *THE RICE PROBLEM IN THE ORIENT*

### *II. The Philippine Experiment*

# BORDEN'S REVIEW
*of*
# NUTRITION RESEARCH

Reviews and summaries of research information concerning nutrition and foods. Published monthly, except July and August, by THE BORDEN COMPANY; officers of the Company: Theodore G. Montague, president; E. L. Noetzel, treasurer; D. T. Orton, secretary. Editorial office: 350 Madison Avenue, New York 17, N. Y.

# *THE RICE PROBLEM IN THE ORIENT*
## *II. The Philippine Experiment*

By RUTH WOODS

The December, 1951, issue of this review presented a discussion of widespread nutritional deficiencies prevalent throughout the Orient. These have been traced in large part to the subsistence of major population groups on diets consisting almost entirely of rice. As pointed out in this earlier review, rice occupies a favorable position among the common cereals as a source of good quality protein and of B complex vitamins. Despite its nutritional advantages, however, rice as the main source of food in the diet can scarcely be expected to provide all of the nutritional essentials which come from a varied diet containing, in addition to cereal grains, such diverse foods as meat, fish, eggs, dairy products, fruits and vegetables. Furthermore, severe nutrient losses are incurred in rice as a result of improper washing and cooking methods.

The solution to the serious problem of hunger and deficiency disease among rice-eating populations — representing more than half the human race — is not easy. It involves changes of many types — economic, social, political, educational — which are both time-consuming and difficult to achieve, or may even be beyond the realm of possibility. For more than thirty years this problem has been the concern of both national and international groups. But beyond delineating the factors contributing to malnutrition in the Orient and setting forth recommendations and resolutions for dealing with these, until recently very little progress had been made toward alleviating the condition.

In 1946, however, a first step was taken which at last set in motion a series of actions aimed toward a practical solution of this world-wide problem. Beginning with the idea of one individual and put into actual operation through the combined efforts of public health agencies, private industry and research, the now-famous Bataan experiment was evolved. It was a truly tremendous undertaking — tremendous in scope, for it involved whole populations; and tremendous in its implications, for its goal was the salvaging of human lives on a world-wide scale.

### *Background of the Bataan Experiment:*

The story of the Bataan experiment began as part of a plan for a world-wide attack on beriberi formulated by Dr. R. R. Williams, chairman and co-founder of the Williams-Waterman Fund for the Combat of Dietary

Diseases.* Although it must be recognized that beriberi is only one manifestation of the serious malnutrition prevalent among rice-eating nations, it is perhaps the most evident one and, according to statistical information, a major cause of disability and death. The eradication of beriberi, therefore, would represent a clearly definable goal as well as a major victory in the attack on malnutrition in general.

It is interesting to note that Dr. Williams began his early work as a chemist in the Philippines. Here, in the early 1900's, he first became aware of the beriberi problem. In 1910, before the first vitamin was actually discovered, Williams learned, through Dr. E. B. Vedder of the U. S. Army Board of Tropical Medicine, that rice bran and polishings had life-saving properties for chickens which became paralyzed as a result of feeding on white rice. The similarity between the symptoms of chick polyneuritis and human beriberi led Vedder and Williams to experiment with the clinical use of crude rice polishing extracts. They found such extracts to be highly successful in curing the human disease even in its most advanced stages.

In the years that followed, Williams — since returned to the United States and working as director of research of the Bell Telephone Laboratories — never forgot the miracle of the rice polishings. He pursued the problem on his own, spending many years in an attempt to synthesize the life-giving ingredient which, in the meantime, had been identified as a vitamin and isolated by other research investigators. In 1936, Williams announced the chemical structure of vitamin $B_1$, and, in collaboration with several colleagues, was able to produce the vitamin by practical synthetic methods.

The industrial synthesis of thiamine made it possible within a few years for large amounts of the vitamin to become available at lowered cost. Patents for the process, assigned to the Research Corporation, provided an income which established the Williams-Waterman Fund for the Combat of Dietary Diseases.

With the availability of thiamine—key vitamin in combating beriberi—and of funds for further research, the possibility of large-scale aid to sufferers from beriberi became more real.

While these researches of Williams and his associates were going on, other studies had indicated the close association between the consumption of white rice and the incidence of beriberi and, further, the urgent need for nutritional improvement of rice diets throughout the Orient (1). The need for an immediate expedient in coping with the situation, as well as the

*Administered by the Research Corporation, New York — a non-profit foundation supporting research programs, chiefly in the physical sciences.

development of long-term programs, was emphasized. A natural outgrowth of the search for an immediate and practical expedient was obviously a plan for enrichment of the chief dietary staple, rice, similar to the bread enrichment program already under way in the United States.

## *Problems Involved in Rice Enrichment:*

Obvious as this solution appeared, however, it was far from easy to put into actual operation. Many difficulties were involved. These were chiefly of economic and technical natures. Of the technical problems involved, perhaps the most difficult was the actual method whereby rice would be enriched with synthetic nutrients. For, while these can be mixed homogeneously into a finely powdered flour, powdered vitamins or even small granules would tend to settle out and be lost if added to rice which is eaten in the form of relatively large, uncrushed grains. Coating each and every particle of rice with a nutrient mixture would involve handling and costs which would be prohibitive.

A second problem was the fact that synthetic vitamins are not available in the Orient, nor do technological facilities for their manufacture exist. Even after the technique of rice enrichment had been perfected, and even conceding the financial ability to import sufficient quantities of synthetic vitamins for enrichment, the problem remained of putting rice enrichment to work on a universal scale through the Orient. This problem, which must still be faced, is complicated by the fact that there are innumerable small rice mills — that there is no centralization of the rice industry — and that introduction of machinery and methods for rice enrichment into all of these widely-scattered small-scale operations may be virtually an insurmountable problem.

Finally, enrichment of rice must be achieved in such a manner as not to noticeably alter either the taste or color of the final product, inasmuch as rice in any form other than conventional white rice is generally unacceptable to a large proportion of the Oriental population.

The Baguio Nutrition Committee which met in the Philippines in 1948 (2) finally concluded that rice enrichment "is likely to prove particularly useful in areas in which beriberi is an important public health problem, but that it should in general be regarded as an expedient which does not remove the need for the improvement of rice diets in other ways." It stressed, particularly, the fact that enriched rice is limited in that — at least according to the originally proposed formula — it provides only a few of the nutrients needed by rice eaters. The committee, nevertheless, expressed the hope that

should any field experiments with enriched rice be conducted, the results be carefully recorded for the benefit of all rice-eating countries.

## *The Bataan Experiment:*

The years that followed the synthesis of thiamine by Williams and co-workers, witnessed the discovery of many new vitamins and, eventually, of their synthesis as well. Information about nutrition became more abundant; the principles and value of flour enrichment were demonstrated in the United States; and the technological problems of enriching rice had been worked out by an American pharmaceutical company (2).* With the end of World War II, the time had finally come when it appeared feasible to try out Dr. Williams' long hoped-for plan for eradicating the scourge of beriberi from the Orient.

Accordingly, in 1946 Dr. Williams went to the Philippines and presented his plan for the combat of beriberi to a joint meeting of the Philippine Medical Association, the Chemical Society of the Philippines and the Philippine Pharmaceutical Association, after an earlier preliminary discussion in the United States with Dr. Juan Salcedo, Director of the Institute of Nutrition in the Philippines. These organizations passed unanimously a joint resolution requesting field trials and studies on the enrichment of rice. This proposal was given immediate acceptance and support by the Philippine government, the U. S. Public Health Service, and the Philippine National Rice and Corn Corporation.

The Province of Bataan was selected as the locale for the experiment for several reasons which included its isolation, the uniformity of prevailing conditions, the self-sufficiency of the area with respect to rice production, and also, the extremely high death rates there from beriberi. In addition, the existence of but one major highway made for more certain control over rice shipments into and out of the entire province and among its individual municipalities.

The Province of Bataan is a relatively isolated peninsula, part of Luzon Island which is the largest of the seven thousand islands that make up the Republic of the Philippines. It is bounded on three sides by the China Sea and Manila Bay. It has no railroad and just one highway which runs the length of the peninsula, connecting around the bayhead with Manila and the provinces to the north. The province is made up of twelve municipalities each consisting of a central town and surrounding villages, all of which have similar agricultural and economic conditions, with rice-growing as one of the

---

*Hoffman-LaRoche, Inc., Nutley, New Jersey.

chief farming occupations. There are some 30 rice mills which supply the local markets with polished white rice.

For the experiment, Bataan was divided into two areas: the experimental zone of smaller but more populous municipalities on the Manila Bay side, which received the enriched rice; and the control zone of the remaining municipalities, which continued to receive their ordinary white rice.

**Objectives of the Experiment:** The objectives of the mass nutritional feeding experiment were fourfold: (1) to determine to what extent beriberi in the Philippines could be remedied by substitution of fortified rice for ordinary white rice; (2) to test the feasibility of the practice in the channels of the rice trade; (3) to inaugurate and test practical inspection systems to insure that only fortified rice was sold; and (4) to popularize enriched rice with the people and to provide a basis for consideration of the use of fortification throughout the Philippine Islands under adequate government control.

The costs of the clinical surveys, of the enriching material, and of the machinery required for mixing this material with the white rice were covered by government and private subsidy.*

## *Preliminary Surveys:*

To form a scientific baseline for the experiment, a clinical survey of beriberi was begun in July, 1947 to assess the existing nutritional status of the population and to serve as a means of comparison with conditions following the introduction and consumption of enriched rice. All of the experimental zones (7 municipalities) and two of the five control municipalities were surveyed by sampling — an average of over 22 per cent of the total population in each zone being subjected to clinical examination. Examinations included physical assessment and dietary surveys. Preliminary findings were reported by Salcedo and co-workers (3) and are summarized in Tables 1 and 2.

From these data it is interesting to note that the incidence of clinical beriberi, with reference to the number of persons examined in each group (Table 1), was highest in "expectant mothers," next in "nursing mothers," then "other adults," "infants," and "children." However, in relation to the total population of the community, the highest incidence of beriberi was found in "other adults," followed by "nursing mothers," and then by "expectant mothers," "children," and "infants." The low incidence in infants

*Philippine and U. S. Governments, the Williams-Waterman Fund, and Hoffman-LaRoche, Inc. which supplied the enriched rice premix.

## TABLE 1

***Incidence of clinical beriberi in Bataan by age, physiological condition and degree of deficiency***

| POPULATION GROUP | FRANK BERIBERI | | | SUGGESTIVE BERIBERI | | | DOUBTFUL BERIBERI | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (a) | (b) | (c) | (a) | (b) | (c) | (a) | (b) | (c) | (a) | (b) | (c) |
| | *no.* | *%* | *%* | *no.* | *%* | *%* | *no.* | *%* | *%* | *no.* | *%* | *%* |
| Infants (0–2 years) | 5 | 0.48 | .040 | 12 | 1.07 | .097 | 16 | 1.56 | .129 | 33 | 3.03 | 0.27 |
| Children (2.01–15 years) | 13 | 0.43 | .105 | 7 | 0.28 | .057 | 24 | 0.68 | .194 | 44 | 1.58 | 0.356 |
| Expectant mothers | 43 | 6.65 | .346 | 74 | 11.45 | .597 | 122 | 18.88 | .985 | 239 | 36.99 | 1.93 |
| Nursing mothers | 79 | 4.78 | .636 | 120 | 7.27 | .970 | 291 | 17.63 | 2.350 | 490 | 29.69 | 3.96 |
| Other adults | 105 | 1.82 | .845 | 230 | 4.16 | 1.860 | 439 | 7.60 | 3.540 | 774 | 13.41 | 6.24 |
| Total population | 245 | ... | 1.99 | 443 | ... | 3.58 | 892 | ... | 7.24 | 1580 | .... | 12.76 |

(a) Number of cases found.

(b) Per cent incidence in group.

(c) Per cent incidence in population.

compared with the high mortality statistics for this group was a significant reflection of the rapidity of fatal terminations in such cases.

Of the total number of persons examined — 12,384 — 1,580 cases of frank or suspected beriberi were found, corresponding to about 13% of the population.

A survey into the dietary practices of the population indicated that 30 per cent of the subjects studied washed rice twice before cooking, 55 per cent three times, and 15 per cent four times. All rice washings were discarded by 81 per cent of the subjects. The average per capita daily food intake in Bataan consisted of rice, 400 g.; leafy vegetables, 20 g.; non-leafy vegetables, 100 g.; dry legumes and nuts, 4 g.; sugar, 16 g.; fish and occasional meat, 150 g.; tomatoes and fruits, 20 g.; of the approximate 2,000 calories per day which this diet furnished, 1,450 calories — or over 70% — came from rice. These facts emphasize the dominance of rice in the prevailing dietaries.

## TABLE 2

*Influence of enriched rice on incidence of clinical beriberi in Bataan classified as to degree of severity and place of residence*
Note: First survey (1947) made before enrichment; second survey (1949) made after enrichment)

| MUNICIPALITY | FRANK BERIBERI INCIDENCE | | | SUGGESTIVE BERIBERI INCIDENCE | | | DOUBTFUL BERIBERI INCIDENCE | | | TOTAL BERIBERI INCIDENCE | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st Survey | 2nd Survey | Reduction | 1st Survey | 2nd Survey | Reduction | 1st Survey | 2nd Survey | Reduction | 1st Survey | 2nd Survey | Reduction |
| | (a)[1] % | (b) % | (c) % | (a) % | (b) % | (c) % | (a) % | (b) % | (c) % | (a) % | (b) % | (c) % |
| *Experimental or enriched rice area:* | | | | | | | | | | | | |
| 1. Hermosa | 1.15 | 0.11 | 90.69 | 2.46 | 0.86 | 65.04 | 9.61 | 0.65 | 93.28 | 13.23 | 1.61 | 87.81 |
| 2. Orani | 0.94 | 0.00 | 100.00 | 1.53 | 0.18 | 88.16 | 6.94 | 0.48 | 93.02 | 9.41 | 0.67 | 92.93 |
| 3. Samal | 0.37 | 0.00 | 100.00 | 1.55 | 0.15 | 90.58 | 7.32 | 0.37 | 95.01 | 9.18 | 0.51 | 94.42 |
| 4. Abucay | 1.53 | 0.16 | 89.73 | 3.59 | 1.34 | 62.81 | 6.19 | 0.63 | 89.85 | 11.30 | 2.12 | 81.23 |
| 5. Balanga | 1.52 | 0.08 | 94.18 | 7.93 | 0.24 | 97.08 | 14.75 | 1.58 | 89.27 | 24.26 | 1.90 | 92.17 |
| 6. Pilar | 2.18 | 0.08 | 96.56 | 3.96 | 0.23 | 94.32 | 4.55 | 0.30 | 93.40 | 10.69 | 0.60 | 94.38 |
| 7. Orion | 5.92 | 0.15 | 97.39 | 6.34 | 1.23 | 80.53 | 3.70 | 2.39 | 35.37 | 15.96 | 3.78 | 76.31 |
| Total | 2.07 | 0.10 | 96.28 | 4.17 | 0.57 | 86.33 | 8.06 | 0.90 | 88.85 | 14.30 | 1.55 | 89.18 |
| *Control area:* | | | | | | | | | | | | |
| 1. Bagac | 2.86 | 1.22 | 57.23 | 1.47 | 1.40 | 4.89 | 1.39 | 1.49 | + 6.91 | 5.72 | 4.11 | 28.18 |
| 2. Moron | 0.16 | 5.63 | + 3,417.50 | 0.81 | 5.10 | + 529.26 | 5.92 | 2.27 | 61.74 | 6.73 | 12.94 | + 92.33 |
| Total | 1.62 | 3.49 | + 115.24 | 1.21 | 3.32 | + 174.29 | 3.83 | 1.89 | 50.65 | 6.66 | 8.70 | + 30.59 |
| Grand total (9 out of 12 municipalities) | 1.99 | 0.78 | 60.66 | 3.58 | 1.14 | 68.18 | 7.24 | 1.11 | 84.74 | 12.76 | 3.03 | 76.27 |

[1] (a) From column (b), table 2, J. Nutrition, *36:* 566, Nov., 1948.

(c) $\frac{(a) - (b)}{(a)} \times 100\%$.

(+) Means increase in incidence.

The average daily intake of thiamine among the populace surveyed was estimated to be about 0.7 mg., just about one-half the recommendations of the Nutrition Section of the Philippine National Research Council: 1.3 to 2.0 mg. for adult males and 1.1 to 1.8 mg. for females, except during pregnancy and nursing when 2.0 mg. per day are desirable.

For further purposes of comparison, mortality statistics for 1947 were assembled. Of the total estimated population of Bataan, 98,457, there were 164 deaths from beriberi of which 138 were infants under two years of age. This represented a mortality rate of more than 166 per 100,000 population.

## *Introduction of Enriched White Rice:*

Before introducing enriched rice on a large scale in Bataan, it was considered desirable to conduct preliminary field trials on a small scale to determine the acceptability of the new rice with respect to its color, taste, odor, palatability and digestibility, as well as to determine whether there would be any appreciable effects on general health and on specific symptoms of thiamine deficiency. This was deemed necessary especially in view of previous disappointing experiences encountered by local public health officials in earlier attempts to introduce brown, under-milled, and parboiled rice.

**Nature of the Enriched Rice:** The enriched rice used in the Bataan experiment was designed to overcome the objections to taste, color, appearance, and the like which might be provoked by the introduction of rice in any form appreciably different from the usual white rice. To all outward appearances it resembled ordinary white rice. As previously pointed out, enrichment of rice presented physical difficulties because of the particulate nature of the rice grains. Treatment of all the rice granules to be consumed would represent an undertaking of impossibly large proportions. The problem was solved by preparing a "premix." This consisted of a small batch of rice in which the individual grains were impregnated with a concentrated solution of thiamine, niacin and iron and the whole protectively coated with an edible film to protect the vitamins from losses during storage and washing. The vitamin content of the premix was such that when one part of this mix by weight is mixed with 200 parts by weight of white, polished rice, the final diluted mixture (i.e. "enriched rice") as delivered contains in each pound, 2.0 mg. of thiamine, 15 mg. of niacin, and 13 mg. of iron.

Actual enrichment of the rice was made at the rice mills in the experimental area. There the highly fortified premix was mixed by special equipment provided free of charge, with the native rice customarily processed for consumers in the area.

**Preliminary Tests:** Preliminary field trials with the enriched rice were made in Bataan on nearly 3,500 individuals including government employees and their families, members of the United States Armed Forces, and children in welfare institutions (4). The product was found to be completely acceptable from the point of view of appearance, taste, and color. In addition, limited observations indicated noticeable beneficial effects on weight and growth gains among the children fed the enriched rice, as well as a decided improvement in peripheral neuritis among members of the Armed Forces personnel.

**Large-Scale Experiment:** On October 1, 1948 the large-scale distribution of enriched rice was finally begun. By the end of that year, only three months later, a drop in mortality rates had already become evident. Whereas in the corresponding three-month period of October through December of the previous year (1947) 44 deaths from beriberi had been reported from the experimental zone, only 20 deaths were reported during the first three months of the enrichment period ending December, 1948. In the control zone there had been eight deaths from beriberi in the three-month period during 1947 and an increase to twelve deaths in the corresponding period for 1948.

When the figures for the next three months were gathered, the results were even more striking. Totals for the six-month periods of October through March showed 96 beriberi deaths in the experimental zone during the pre-enrichment period and only 36 deaths during the period of enrichment. In the control zone, the totals were 22 and 25 deaths, respectively.

After another three months of enrichment the figures were compiled again. Total beriberi deaths in the experimental zone for October through June in the pre-experimental period were 132; in the same nine months of the enrichment period, they had dropped to 45.

Finally, the figures for the first full year of enrichment became available. The downward trend had continued in the experimental zone, while the figures for the control area remained almost constant. A slight decrease in beriberi mortality in parts of the control zone during the last three months was traced to infiltration of the enriched rice into the control area.

During the full year of enrichment there had been, then, a decline of more than 67 per cent in beriberi deaths in the experimental zone and an increase of 2.4 per cent in the control area, as compared to the year immediately prior to enrichment. By the time the seventh three-month period had been reached, following the introduction of enriched rice, not one death from beriberi was recorded in any of the seven municipalities in the enrichment area.

It has been pointed out that enrichment might have shown its full effect sooner had it not been for the extra time it took to reach infants too young to eat the enriched rice. During the first year when the whole mortality rate had dropped 67 per cent, infant deaths decreased only 50 per cent. This was because the mothers' tissues had to be built up in thiamine before adequate vitamin levels could be reflected in the milk available to the babies.

## *Post-Enrichment Surveys:*

Following the introduction of rice enrichment on a large scale in October, 1948, a second survey of the health and nutritional status of the population was undertaken (5). This survey was conducted after the rice enrichment program had been in force for nearly a year and included the period from July, 1949 to the end of February, 1950. The results were then compared with the preliminary survey made in 1947 prior to the introduction of enriched rice. These are summarized in Table 3.

In general, the findings indicate a decline in the incidence of beriberi of 76 to 94 per cent in each of the seven municipalities receiving the enriched rice (weighted average 89 per cent). In the nearby control area, the incidence of beriberi rose slightly within the same period.

Mortality rates due to beriberi have similarly declined from 263 per 100,000 in the experimental area in 1947-1948 to 28 per 100,000 in 1949-1950 at the time of the second nutrition survey. As already indicated previously, the mortality later dropped to zero as of the three-month period from April to June, 1950 (6).

**Specialized Survey Techniques:** Beginning in August, 1948, just prior to the introduction of the large-scale rice enrichment program, the preliminary medical and dietary survey conducted by Salcedo *et al* (3) was supplemented by additional nutrition surveys using recently developed microtechniques for determining the levels of various nutrients in the blood and serum (7). These latter surveys, based on the microanalytical techniques developed by Bessey, Lowry and associates (8, 9, 10), made it possible to estimate the nutritional status of large numbers of persons through the examination of small blood samples obtained from fingertip punctures. Analyses were made for thiamine, hemoglobin, serum protein, vitamin A, carotene and vitamin C. The objective was to evaluate in a more definite and quantitative manner the state of nutrition of the population sample and to establish a baseline, comparable to that established by the survey of Salcedo *et al* (3) for later comparison following the enrichment period.

Examinations were made of persons classified as having beriberi as well

# TABLE 3

***Frequency of signs and symptoms in clinical beriberi in Bataan by age, physiological condition and degree of deficiency*** [1]

| BODY REGION OR SYSTEM INVOLVED WITH SIGNS AND SYMPTOMS | INFANTS (0–2 YRS.) (33)[2] | | | CHILDREN (2.01–15 YRS.) (44) | | | EXPECTANT MOTHERS (239) | | | NURSING MOTHERS (490) | | | OTHER ADULTS 15 YEARS AND OVER (774) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F[1] | S | D | F | S | D | F | S | D | F | S | D | F | S | D |
| *Mouth:* | | | | | | | | | | | | | | | |
| Cyanosis | 4 | 9 | | 2 | | | 5 | 3 | | 28 | 17 | | 38 | 29 | 1 |
| Numbness of lips | | | | | | | 18 | 15 | 16 | 31 | 46 | 63 | 33 | 58 | 88 |
| Tremor of tongue | | | | | | | 1 | 1 | | | | | 5 | | |
| *Gastrointestinal:* | | | | | | | | | | | | | | | |
| Anorexia | | | | | | 1 | | 6 | 2 | 6 | 9 | 10 | 7 | 12 | 27 |
| Vomiting | | 2 | | | | | 2 | 1 | | 9 | 2 | 1 | 6 | 2 | |
| Constipation | 1 | 1 | | | | 1 | 4 | 8 | 11 | 8 | 21 | 30 | 17 | 22 | 49 |
| Waist tightness | | | | | 1 | | 10 | 8 | 15 | 27 | 25 | 34 | 32 | 46 | 59 |
| *Cardiovascular:* | | | | | | | | | | | | | | | |
| Fatigability | | | | 9 | 3 | 5 | 26 | 41 | 48 | 43 | 52 | 80 | 62 | 102 | 165 |
| Palpitation | | | | 3 | | 4 | 20 | 27 | 32 | 35 | 52 | 62 | 45 | 75 | 149 |
| Tachycardia | | | | | | | 12 | 4 | | 9 | 5 | | 14 | 21 | 1 |
| Murmurs | | | | 1 | | | 2 | 1 | | 4 | 2 | | | 1 | |
| Enlarged heart | | | | 5 | 2 | | 4 | 1 | | 3 | | | 5 | 2 | |
| Edema | | | | 1 | | | 21 | 32 | | 7 | 11 | | 20 | 33 | 1 |
| *Nervous system:* | | | | | | | | | | | | | | | |
| Tingling | | | | 6 | 5 | 14 | 33 | 59 | 88 | 61 | 101 | 222 | 80 | 192 | 351 |
| Numbness | | | | 14 | 7 | 18 | 37 | 58 | 97 | 66 | 113 | 254 | 89 | 203 | 398 |
| Reflex changes | | | | 8 | 2 | | 11 | 8 | | 43 | 29 | | 56 | 72 | 2 |
| Paresthesia | | | | | | | | | 6 | 6 | 5 | 11 | 7 | 12 | 26 |
| *Skin and muscles:* | | | | | | | | | | | | | | | |
| Pallor | | 1 | | 11 | 1 | | 26 | 11 | | 59 | 42 | | 70 | 54 | 1 |
| Tenderness (calf) | | | | 6 | 3 | 11 | 24 | 28 | 58 | 30 | 44 | 141 | 40 | 77 | 283 |
| Cramps | | | | 8 | 6 | 11 | 38 | 56 | 93 | 60 | 68 | 175 | 76 | 151 | 216 |
| *Infantile beriberi:* | | | | | | | | | | | | | | | |
| Ptosis | | | | | | | | | | | | | | | |
| Purposeless motions | 3 | | | | | | | | | | | | | | |
| Opisthotonus | 5 | | | | | | | | | | | | | | |
| Head drop | 1 | | | | | | | | | | | | | | |
| Aphonia | 2 | 10 | 16 | | | | | | | | | | | | |

[1] F = frank beriberi; S = suggestive beriberi; D = clinically doubtful beriberi.
[2] Number of cases examined.

as of those who appeared to be normal. The clinical classification of the test persons as to beriberi symptoms made it possible to relate the findings on thiamine in blood to the severity of the symptoms if sufficiently large

groups were compared. Since the blood levels and clinical ratings measured different, but in some ways related, phenomena, it is not surprising that in individual instances the low levels in blood did not parallel the severity of the symptoms of beriberi. As the authors point out, the blood level reflects primarily the dietary intake, whereas the appearance of tissue changes is indicative of protracted deficiency.

Of the more than 200 persons examined by the microchemical methods, three-fourths had been classified by the earlier survey (3) as having beriberi and one-fourth was regarded as normal. The average blood level of thiamine of all persons was 3.6 micrograms per 100 ml. of blood; of the non-symptomatic group, 4.0 micrograms. Persons with evidence of beriberi also exhibited significantly lower levels for hemoglobin and protein as well. In persons apparently free of beriberi, however, blood levels of various nutrients indicated appreciable deficiencies. Widespread anemia was evident; serum protein levels were generally low (lowest levels occurring in the frank beriberi group of pregnant women—a possible overlapping of stress symptoms of pregnancy with nutritional deficiency); serum vitamin C and carotene levels were generally extremely low reflecting a low consumption of fresh fruits and vegetables. Serum vitamin A levels, however, appeared to be normal.

It was planned to repeat these studies following one year of rice enrichment. It will be extremely interesting to learn what the results of these later findings will be.*

---

*As this issue goes to press, the results of this survey have just appeared [Burch, H. B., J. Salcedo, Jr., E. O. Carrasco and C. L. Intengan. Nutrition resurvey in Bataan, Philippines, 1950. *J. Nutr.* 46 239 (1952)]. Following is a summary of the findings as reported:

"A nutrition resurvey by microchemical methods and a dietary and clinical study have been made in Bataan on 200 persons. Sixty-four per cent of these were examined in both 1948 and 1950.

"Results of chemical analysis of blood and urine in 1948 and 1950 are informative concerning the effects of current intake of certain of the vitamins and minerals. The marked increases in blood and urinary thiamine and in hemoglobin indicate a major change in the intake of thiamine and iron in the diet. These increases are mainly attributable to the consumption of enriched rice, since its introduction constituted the only major dietary change in this isolated agricultural peninsula where the pattern of food intake was well established. Indirectly, the finding of undesirably low urinary riboflavin in 1950 contributes to the evidence that the increases in thiamine levels were due to rice enrichment, since riboflavin and thiamine often occure together in (natural) foods. The findings point toward the need for the further enrichment of rice by adding riboflavin.

"The findings revealed no significant change in the low concentration of vitamin C in serum. This would indicate that consumption of foods rich in vitamin C, such as leafy vegetables, tomatoes and citrus fruits, had not changed. Likewise, the serum carotene values remained low, a finding attributable also to the continued low intake of vegetables and fruits. The serum vitamin A and protein remained in a satisfactory range.

"The results of the dietary study are for the most par tin accord with the chemical findings. They also point toward satisfactory intakes of thiamine and iron and toward lack of ascorbic acid and riboflavin. In addition, they reveal a critical lack of calcium.

"The chemical findings on changes in thiamine levels and in hemoglobin concur with the clinical reports on the improvement in health of the people following the inauguration of the enriched rice program in Bataan."

## *Evaluation of the Rice Enrichment Program:*

The enrichment of white rice with thiamine, niacin and iron to levels providing in one pound recommended daily amounts of these nutrients, plus marginal amounts to compensate for losses in storage and handling, has completely eliminated deaths from beriberi in an experimental area in Bataan where mortality rates were previously exceptionally high. It has further improved the general nutritional level and health of the populace as determined by medical and nutrition surveys before and after the introduction of the enrichment program.

The present rice enrichment program, however, has certain limitations. There are economic and technological problems. These involve the cost of vitamins and of equipment for preparing material locally, as well as for blending the premix with ordinary milled rice. Although it has been pointed out that these costs can be held to a minimum, involving as little as 35¢ extra per capita for a year's supply of enriched rice, this is not negligible in areas where the average family cash income may be about $40.00 per year. There remains also the problem of overcoming inertia, resistance and ignorance not only on the part of the people involved, but of government agencies whose interest and cooperation must first be obtained. The need for accumulating reliable statistics on the incidence, severity and mortality rates from beriberi in the other rice-eating countries of the Orient has been stressed as perhaps the single most important factor in establishing the necessity for the improvement of rice diets in the minds of the various governments. The Philippine experiment is a case in point. Had there been no statistics indicating the seriousness of the beriberi problem, it is unlikely that the field trials with enriched rice would have ever been carried out. Nor could there have been the means for evaluating such an experiment without already existing statistical data for comparison. The availability of such data in the Philippines and, to some extent in Japan, are strong indications that investigations in other rice-eating countries would undoubtedly reveal a similar incidence of beriberi as a major public health problem.

Improvement of rice diets may be possible other than by artificial enrichment. These include extension and improvement of parboiling practices in areas where such rice has proved acceptable, as in India, or the use of modern "conversion" methods which are based on the principle of parboiling. Such methods increase the nutritive value of white rice by causing penetration of nutrients from the bran into the kernel. Here again, the setting up of modern plant facilities for conversion — which involves the treating of all of the rice grains — may prove to be an unsurmountable obstacle from the economic and technological point of view. Rice enrichment, which in-

volves treating only a fraction of the rice (one part in 200), is probably simpler and more economical and has the added advantage of producing a product which does not differ in taste or appearance from the highly-milled white rice so much in demand.

The present enrichment formula, moreover, provides only a limited number of the nutrients lacking in the diets of rice-eating people. While it may be possible to add certain other nutrients, without excessive increase in cost, a further problem is introduced with the introduction of such materials as riboflavin which strongly colors the premix grains. Finally, no one food can provide a well-balanced nutritionally adequate diet. Rice, no matter how enriched, is no exception. The ultimate goal for improved nutrition in the Orient is the provision of additional foods to provide more calories and much-needed animal protein as well as vitamins and minerals. The cultivation of potatoes and sweet potatoes; major expansion of the fishing industry; the development and use of food yeast; conversion of waste land to grazing areas for dairy cattle or goats — these are some of the ways for making better diets available. It must be recognized, however, that it may be many decades before such a goal is achieved if, indeed, it ever is.

Enriched rice is at best only a partial substitute for such diets. However, the Bataan experiment has shown clearly that enriched rice can act as a major stop-gap in effecting nutritional improvement. Indeed, as has been remarked (6), "Perhaps the greatest significance of the Bataan project is to point up the possibility of doing something about beriberi *now.*"

The ready acceptance of enriched rice in Bataan and the striking improvement in general health and reduction in mortality due to its use are the strongest arguments in favor of a rice enrichment program. Finally, the Bataan experiment has shown that public health may be benefited and improved by large scale application of nutritional principles no less than by the large scale use of other major advances in public health such as vaccination, insect control, water purification and pasteurization of milk.

## REFERENCES CITED

1. WOODS, R. Nutrition in Public Health. I. The Problem of Rice Eating Populations in the Orient. *Borden's Review of Nutrition Research,* December (1951).

2. FURTER, M. F., W. M. Lauter, E. deRitter, and S. H. Rubin. Enrichment of rice with synthetic vitamins and iron. *Ind. & Eng. Chem. 38,* 486 (1946).

3. SALCEDO, JR., J., E. O. Carrasco, F. R. Jose, and R. C. Valenzuela. Studies on beriberi in an endemic sub-tropical area. *J. Nutr. 36,* 561 (1948).

4. SALCEDO, JR., J., A. Pedroche, E. C. Panganiban, and J. R. DeLeon. Artificial enrichment of white rice as a solution to endemic beriberi. *J. Nutr. 38,* 443 (1949).

5. SALCEDO, JR., J., M. D. Bamba, E. O. Carrasco, G. S. Chan, I. Concepcion, F. R. Jose, J. F. DeLeon, S. B. Oliveros, C. R. Pascual, L. C. Santiago, and R. C. Valenzuela. Artificial enrichment of white rice as a solution to endemic beriberi. Report of field trials in Bataan, Philippines. *J. Nutr. 42,* 510 (1950).

6. ANON. Better health through better rice. Williams-Waterman Fund, Research Corp., N. Y. (1950).

7. BURCH, H., J. Salcedo, Jr., E. O. Carrasco, C. L. Intengan, and A. B. Caldwell. Nutrition survey and tests in Bataan, Philippines. *J. Nutr. 42,* 9 (1950).

8. BESSEY, O. A., O. H. Lowry, M. J. Brock and J. A. Lopez. The determination of vitamin A and carotene in small quantities of blood serum. *J. Biol. Chem. 166,* 177 (1946).

9. LOWRY, O. H., and T. H. Hunter. The determination of serum protein concentration with a gradient tube. *J. Biol. Chem. 159,* 465 (1945).

10. LOWRY, O. H., J. A. Lopez, and O. A. Bessey. The determination of ascorbic acid in small amounts of blood serum. *J. Biol. Chem. 160,* 609 (1945).

## *NEWS DIGEST*

**NUTRITION AND PREGNANCY:** The importance of good nutrition during pregnancy as a factor in maternal health and in the immediate as well as future status of the child has become increasingly apparent in recent years. The need for improving maternal diets has been repeatedly demonstrated by analyses of typical diets among all classes of women. Most recent of these surveys, conducted from November 1949 to January, 1951, confirms the findings that nutrition education and guidance of pregnant women must be vigorously extended. This most recent study was concerned with over 400 women, of low-income groups, in a typical rural area (Iowa) of the United States. The findings showed that poor food habits derived from early childhood and, in addition, often reflected superimposed food likes and dislikes of the husband. In general, caloric intake was adequate. The bulk of the calories, however, was represented by bread (often 9 slices per day) and potatoes. Major deficiencies were found in protein, calcium and riboflavin. The high intake of potatoes contributed to the adequacy of iron and vitamin C; vitamin A levels were adequate due chiefly to the use of fortified margarine, tomatoes and carrots. Milk and eggs were scarce in most diets.

The bread enrichment program contributed heavily to the dietary supply of thiamine, iron and riboflavin although the intake of the latter was still below recommended levels. The relative cheapness of pork liver made this a fairly frequent item of the diet in terms of the meat supply, thereby also contributing to the intake of these three nutrients. The authors conclude that, in addition to the

present program, "enrichment of bread" with a greater amount of non-fat dry milk solids also would improve the nutrition of these women and their families by automatically increasing their intake of calcium and animal protein. In fact, the enrichment of all bread with non-fat dry milk solids to the maximum amount consistent with production of a good loaf would automatically improve the diet of the general population of the Northern half of the United States in those nutritional factors most commonly deficient.

The need for greater intake of milk and milk products is of major importance in pregnancy. The addition of even a pint of milk daily would better the intake of protein and riboflavin in the poorest diet to a real degree and would more than double the present intake of calcium of nearly half the women. A quart of milk daily would produce the greatest dietary benefit of any single food addition, for calcium, protein, and riboflavin are present in least amounts in the diets of these women. The use of low cost dry milk solids would benefit greatly those unable to buy sufficient fresh milk.—*J. Am. Diet. Assoc. 28,* 27 (1952).

**PROTEIN QUALITY OF WHOLE WHEAT:** Recent studies indicate that heat processing of whole wheat results in an apparent improvement in the biological value of the protein as measured by rat feeding experiments. Many proteins have been shown to be adversely affected by heating; while, on the other hand, certain legume proteins—notably those of the soy bean—are materially improved by such treatment. The present report is the first published instance of protein change during the moist heat treatment of whole wheat. The reason for the increase in nutritive value of this protein has not been determined. Additional observations indicate that drying of the cooked whole wheat, such as occurs in the commercial preparation of shredded wheat, does not interfere with the nutritional improvement obtained in the preliminary cooking procedures.—*Proc. Soc. Exp. Biol. Med. 78,* 450 (1951).

**CORTISONE AND VITAMIN $B_{12}$:** Large doses of cortisone have been reported to inhibit both body and hair growth in experimental animals, as well as to depress normal food intake which may further contribute to the reduced growth effects. Similar growth inhibitions have been reported to result from treatment with thyroid active substances, estrogenic hormones or thiouracil. In these latter cases, vitamin $B_{12}$ has been found to be effective in overcoming the growth inhibition. Similarly, several antibiotics have been found to overcome growth inhibition in hyperthyroid animals. These facts led to the belief that marked changes in strogen or thyroid levels may increase the need for vitamin $B_{12}$ and possibly other factors. This led to the combined use of vitamin $B_{12}$ and aureomycin (a demonstrated growth-promoting antibiotic) as a possible means of overcoming the growth inhibition accompanying the use of large doses of cortisone. Each of these materials was partially effective when fed alone; maximum results were achieved with combined feeding of $B_{12}$ and aureomycin. A protective effect on the growth of the thymus gland of immature rats was also noted. The favorable actions of $B_{12}$ and aureomycin were accompanied by an increase in food consumption and greater efficiency in converting food into body weight gains. It was concluded that when large doses of cortisone are injected into vitamin $B_{12}$-deficient animals, the deficiency becomes aggravated and thus accounts, in part, for the depression of body and hair growth. No explanation is as yet available for the protective effect on the thymus gland.—*Proc. Soc. Exp. Biol. Med.* 78, 692 (1951)